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vided for supplying nitrogen and liberating mineral plant food in rational systems of farming, the relationship between the chemical composition of the soil and crop production is normally very apparent. Irrational systems often give abnormal results, and their correct interpretation requires that no important factor of influence shall be ignored.

It may be added that the wheat from our well-treated and high-yielding plots is not of poor quality, but of very high grade, and has been sold to the experienced grain buyer at a premium as high as 15 cents per bushel above that paid for wheat from unfertilized well-rotated land.

In Illinois, as in all other states, most of the soil and crop investigators are men of large practical farm experience, but we also have deep respect for the science of analytical chemistry, as the only means of determining the total stock of plant food in the soil, and for the science of biochemistry, as the chief means of making plant food available.

Chemists and agronomists must honor Jensen for the information and method which he gave to the world relating to the destruction of fungous diseases sometimes carried in seed grain, and we honor Bolley for his valuable contributions in this field of agricultural research; but we also recognize that the avoidance of fungous diseases as one among the many advantages and reasons for crop rotation and for the proper handling of crop residues is not a new idea, for it has been advanced, explained and emphasized by numerous investigators for many years. The persistent efforts to belittle the importance of positive soil enrichment and preservation in permanent rational systems of farming, whether by improvident landowners, by Whitney and Cameron, of the Bureau of Soils, or by Professor Bolley, are the greatest curse to American agriculture and the greatest danger to permanent prosperity in this country.

The fact that the earth is round became generally accepted two or three centuries after its discovery; and it required a full century for Europe to half appreciate the great dis-

covery by De Saussure, so well expressed in the words of Liebig:

It is not the land itself that constitutes the farmer's wealth, but it is in the constituents of the soil, which serve for the nutrition of plants, that this wealth truly consists.

The foundation principles for the restoration and preservation of the fertility and productive power of normal soils are simple and well-established, and no state in the union can afford to ignore or belittle these great fundamental truths, nor to have the minds of its farmers and landowners befogged in relation thereto.

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SCIENTIFIC BOOKS

The Living Plant. By WILLIAM F. GANONG. New York, Henry Holt and Co. 1913. 17×23 cm. Pages xii+478; 3 colored plates; 178 figures, many in text. Price, \$3.50.

This book aims to attract popular interest and at the same time to tell the truth about its subject. The work is avowedly not intended for scientists, but "it seeks to present to all who have interest to learn an accurate and vivid conception of the principal things in plant life" (preface). Thus the author has "been at more pains to be clear than to be brief," and the book "has wandered through a leisurely course to a length quite shockingly great" (preface). Nevertheless, the depth in natural science to which the reader is here carried is so great as to make it probable that the book will find its greatest use among those who already possess considerable knowledge of plants and their processes.

The style of the book combines clearness with personal frankness, the reader being taken into the author's confidence from the very first; it is a conversational style of the highest type, becoming even chatty at points, and generally maintaining a logical clearness and definiteness that is rare in popular or even elementary treatises upon such complex subjects. The language possesses a characteristic quaintness, almost an archaic tang at some points. A few examples of quite col-

loquial or even slang expressions may be noted. Regarding the numerous illustrations, they are exceedingly well chosen and well prepared, and they add markedly to the clearness of the exposition.

The author's attitude is conservative and many questions are left just as they should be, in a quite undecided condition. At the same time, the reader is admitted to some of the pleasures of hypothesis-making and of prophecy, generally in a very safe and clearly guarded manner, for the author has not hesitated to enliven his story and perhaps accelerate the advance of his science, by indulging in suggestions of scientific possibilities and probabilities.

"A table designed to display the plan of this book" is inserted after the table of contents, and exhibits a sort of synoptical outline of the subjects considered in the eighteen chapters, together with their logical connections. It is seldom that a book of this sort brings out as clearly as does the one before us the important relations of its various topics to each other and to human activities in general. Diagrams and tables are frequently resorted to. After a chapter on the ways in which plants appeal to human interest, seven chapters treat the material and energy transformations in the plant body. Then follows a chapter on irritability, one on "protection," two on reproduction, and two on growth. The four remaining chapters consider respectively, dissemination, evolution and adaptation, plant breeding and classification. This obviously very broad treatment comprises a sufficiency of new methods of presentation and novel placings of emphasis to make the book profitable reading for the research worker and the teacher as well as for the less advanced student.

Turning now to fault-finding, a few adverse criticisms may be noted as to use of words. The word *mani-colored* occurs in several places (*e. g.*, page 261); does not such a novelty suggest *handpainted*? Insectivorous plants are termed *insectivora* (page 104, for example); if the Latin form is employed we should prefer not to apply the neuter form to

plants (*plantæ*). In these decadent days, as far as general interest in the ancient foundations of our language is concerned, it were perhaps better to cling to the perfectly safe but less euphonious English form, insectivores. The word *plenty* appears to be used throughout (*e. g.*, pages 140, 266) as a predicate adjective, where ordinary usage requires plentiful, plenteous or a word with some other root. To most scientists, and perhaps to most readers, these points may seem of little import, but the very excellence of the diction which characterizes this book as a whole renders its few shortcomings of this sort all the more outstanding.

As to the scientific matter itself, probably the only quite inadequate exposition occurs in connection with the discussion of capillarity (pages 180, 181), which, as it stands, seems to the reviewer logically quite hopeless. It is to be regretted that the author surrendered here to the suasion from his critic and forbore "to explain this interesting process in detail to the reader" (page 179).

All will agree with Professor Ganong, that any truthful chapter on protoplasm must "leave you with a very unsatisfied feeling" (page 164), but it does seem that the conception of this material might be clarified by the omission of the idea of "*protoplasm par excellence*" (page 143), letting the mixture of many substances stand for the present as the seat of the numerous, more or less peculiar processes which taken together make up life. If it pleases one's fancy to think that vitality is possessed by some single substance in protoplasm and that all other contained substances are to it merely environmental or conditional, no one can assert that such a view is illogical; this is purely a matter of feeling, over which we do not argue. But none can agree with the author, that "we are logically bound to believe that some such substance [as protoplasm *par excellence*] must exist as the seat of the distinctive properties of life" (page 143). Some people may be bound to believe this, but they are assuredly not *logically* so bound; nothing is now known of protoplasm which forces such an issue.

Likewise, it is difficult to find grounds for agreeing with the author when he states (page 199) that transpiration is a process "for which there is no equivalent in animals." Excepting when the higher animal is covered with water there is always more or less cuticular transpiration from its skin, just as there is in plants, and the wet membranes of the lungs and air passages are always transpiring large amounts of water into the internal atmosphere, just as happens in plant foliage and the like. Transpiration is a phenomenon common to all living things which are exposed to air, though its indirect effects are of course different in different forms.

A method of exposition to which many botanists will probably object, but which will no doubt receive the hearty approval of most physiologists, is the presentation of the entire subject of sexual reproduction without reference to the alternation of generations. From the dynamic point of view, it is surely desirable for an elementary treatise thus to omit the complicated story of sporophyte and gametophyte, megaspores and microspores. The reviewer looks upon this as a real stroke of genius, considering the dominance of these things in present-day botany.

Last, but not by any means least, among the points selected for mention here, is what may be termed the philosophy of the book before us. The whole presentation is frankly and insistently permeated with the peculiar confusion, so common in biological reasoning, of causes with effects; the account is written from the teleological standpoint. The author adds a new deity to the growing biological pantheon, thus developing "a perfectly natural vitalism based on the superior interpretative power of a hypothesis assuming the existence in nature of an *X*-entity, additional to matter and energy but of the same cosmic rank as they, and manifesting itself to our senses only through its power to keep a certain quantity of matter and energy in the continuous orderly ferment we call life" (page viii). To the purposefulness of this unknown Something are attributed the determining conditions that bring about the more complex

phenomena of living things; wherever the physical antecedents or determining conditions of a phenomenon are not known (and they are mostly unknown in physiology), the hypothesis of the *X*-entity supplies a word with which to cloak our ignorance—as Professor Barnes used to say—and in this seems to lie the "superior interpretive power" of such hypotheses.

But this is not the place to add to the already great and bemuddled mass of academic argument concerning this present-day survival of the doctrine of special creation. Space may be taken to note further only three interesting aspects of the general philosophical attitude of "The Living Plant." First, non-teleologists will welcome the frankness and clearness with which the position of the author has been stated. While many teleologists explain the prevalent use of purposeful implications merely as verbal short-cuts, disavowing all belief in what the words actually state, and while such vague mental positions seem to give some weight to the accusation that it is but a "man of straw" against which the scientific monist directs his javelin, our present author makes it perfectly and unmistakably clear that he does hold to purpose as a logical cause of phenomena in matter and energy. Such clear statements must do much to clarify the atmosphere of this seemingly everlasting discussion.

The second interesting philosophical feature requiring some attention here is this, that along with the *deus ex machina* postulated to guide the threads through the active loom of time, and along with the common, every-day forces of the physical sciences, which seem to be conceived as keeping the loom in operation, there seems also to be (though the author does not definitely bring this out) a third force, or at least a third kind of factor, which takes part in conditioning phenomena, namely, *accident* or *chance*. One comes away from a careful reading of the entire presentation with a feeling that vital phenomena are brought about through the interaction of these three groups of directing conditions, the *X*-entity, nature and chance. No doubt the author will

agree, however, that chance is nothing but the very thing which emerges to some of us in his X-entropy, just some complex of conditioning factors not yet known.

Finally, the book before us is pedagogically nearly ideal, and it may be that its teleological philosophy is one of its strong points in this regard. As the author will assuredly agree, scientific research is one thing and the teaching of science quite another; the elementary teacher does not try to tell the whole truth, but only those portions which may best lead on to such a state of mind in the student as will some time, perhaps, enable him to understand a large portion of the truth. Now, considering that physical causation is far too complex a subject even to be thought about adequately, until the thinking person has accumulated a vast store of accurate scientific experience, it may well follow that a perfectly monistic philosophy would not serve at all in an elementary treatise, and that a somewhat *devitalized* dualism is the only sort of inclined plane by which the scientifically untrained mind may be led toward the highest and clearest altitudes of scientific philosophy.

In conclusion, the book we have been considering is one of the American Nature Series, is bound in green cloth with a gilt-ornamental back, and is about 4 centimeters thick. It will always be read lying on the table. The paper stock is very heavy, clay-coated and highly surfaced, so that the numerous half-tone illustrations are exceedingly satisfactory. It is, however, also true that the position of the book and reader must be properly chosen to avoid dazzling high lights where the midnight lamp is reflected in the mirror-like surface of the paper. As with all such coated papers, a distinct odor of glue is perceptible throughout the reading; spattered water will play havoc with the pages.

B. E. LIVINGSTON

Studies in Luminescence. By EDW. L. NICHOLS and ERNEST MERRITT. Published by the Carnegie Institution of Washington, 1912. Royal 8vo, vi + 225 pp.

The memoir represents the results of investigation extending over a period of nine years. In large part it gives the experimental observations made by the authors; but in it are also observations on one or another phase of the general subject, made by other observers, mainly, however, under the guidance of the authors. The work has been aided by occasional grants of money from the Carnegie Institution of Washington, and the memoir is published by the institution. The material has been published previously in separate articles, most of which have appeared in the *Physical Review*; but it has now been given such continuity of form and (in the last two chapters of the memoir) such valuable theoretical discussion as to make the present publication one of unusual interest and value.

The authors, during these years, have evidently kept steadily before themselves the intention of using the spectrophotometer to the farthest possible extent. The success with which they have held to such intention, in investigations of a dozen or so of luminescent substances, is nothing short of remarkable. Measurements of intensities have been carried out far toward the edges of fluorescent and phosphorescent bands. In the cases of nearly all substances investigated, measurements were made to determine the exact form and extent of absorption bands corresponding to given luminescence bands. The dependence of the intensities of luminescence upon the wavelength of exciting light, and the distribution of intensities for some substances when excited by Röntgen rays and by cathode rays, have been studied. More remarkable still is the extent to which the spectrophotometer has been used in following the decay of phosphorescence at various wave-lengths in chosen bands. When one considers how weak the illuminations in the comparison fields of this instrument are, at the limits of a band or after some time of decay, the range of application which the method finds is surprising. Numerous settings were made with intensities in the comparison fields so small as to convey to the observer no sensation of color. The concord-